

Listing of claims:

1. (currently amended) A solid state surface catalysis excitation transfer reaction apparatus comprising:  
a catalytic excitation collector; and  
an excitation emitter including a semiconductor p-n junction diode whose at least one of excitations and band structure is coupled to at least one of excitations and band structure associated with the catalytic excitation collector,  
wherein one or more energies associated with reactions of adsorbates occurring in the catalytic excitation collector are converted into excitations and transported to the excitation emitter where emitter excitations are generated and converted into one or more forms of energy in the excitation emitter.
2. (currently amended) The apparatus as claimed in claim 1, wherein the reactions of adsorbates occur on a surface of the catalytic excitation collector.
3. (currently amended) The apparatus as claimed in claim 1, wherein the reactions of adsorbates occur with a surface of the catalytic excitation collector.
4. (original) The apparatus as claimed in claim 1, wherein the one or more energies include one or more excited reactant molecular vibrations.
5. (original) The apparatus as claimed in claim 1, wherein the one or more energies include one or more molecule-surface vibrations.
6. (original) The apparatus as claimed in claim 1, wherein the one or more energies include one or more atom-surface

vibrations.

7. (original) The apparatus as claimed in claim 1, wherein the one or more energies include one or more adsorption reactions.

8. (original) The apparatus as claimed in claim 1, wherein the one or more energies include one or more chemical reactions.

9. (original) The apparatus as claimed in claim 1, wherein the one or more energies include one or more excited electronic states.

10. (original) The apparatus as claimed in claim 1, wherein the excitations include one or more hot carriers.

11. (original) The apparatus as claimed in claim 1, wherein the excitations include one or more electromagnetic fields.

12. (original) The apparatus as claimed in claim 1, wherein the emitter excitations include one or more minority carriers.

13. (original) The apparatus as claimed in claim 1, wherein the emitter excitations include one or more hot carriers.

14. (previously presented) The apparatus as claimed in claim 1, wherein the emitter excitations include energies transported by carrier diffusion.

15. (currently amended) The apparatus as claimed in claim 1, wherein the emitter excitations include the coupling electric fields which couple catalysts, adsorbates, conductors and semiconductors, the catalysts and adsorbates being elements that

form the catalytic excitation collector, and the conductors and the semiconductors being elements that form the excitation emitter.

16. (currently amended) The apparatus as claimed in claim 1, wherein the emitter excitations include one or more excitons in the excitation emitter.

17. (currently amended) The apparatus as claimed in claim 1, wherein the emitter excitations include one or more of plasmons and evanescent fields on or near the surface of metals.

18. (currently amended) The solid state surface catalysis excitation transfer reaction apparatus as claimed in claim 1, wherein the catalytic excitation collector is in contact with the excitation emitter.

19. (currently amended) The apparatus as claimed in claim 1, wherein the ~~p-n-junction~~ semiconductor diode is forward biased.

20. (currently amended) The apparatus as claimed in claim 1, wherein the emitter excitations are created when the semiconductor diode ~~p-n-junction~~ becomes forward biased due to externally applied energy.

21. (currently amended) The apparatus as claimed in claim 20, wherein an electric potential applied across the ~~p-n-junction~~ semiconductor diode causes a forward bias in the ~~p-n-junction~~ semiconductor diode.

22. (currently amended) The apparatus as claimed in claim 20, wherein optical absorption of photons in the ~~p-n-junction~~

semiconductor diode causes the forward bias in the ~~p-n-junction~~ semiconductor diode.

23. (currently amended) The apparatus as claimed in claim 10, wherein the one or more hot carriers include one or more hot electrons.

24. (currently amended) The apparatus as claimed in claim 1, wherein the ~~p-n-junction~~ semiconductor diode includes a p-type excitation emitter region and an n-type base.

25. (currently amended) The apparatus as claimed in claim 1, wherein the ~~p-n-junction~~ semiconductor diode includes a highly doped p+ region.

26. (original) The apparatus as claimed in claim 24, wherein the p-type emitter region is highly doped.

27. (currently amended) The apparatus as claimed in claim 1, wherein the ~~p-n-junction~~ semiconductor diode includes a highly doped n+ region.

28. (original) The apparatus as claimed in claim 24, wherein the n-type base is highly doped.

29. (original) The apparatus as claimed in claim 1, wherein the excitation emitter is fabricated from semiconductor material that includes any one or combination selected from In, Ga, As and Sb.

30. (original) The apparatus as claimed in claim 1, wherein the excitation emitter is fabricated from semiconductor material

that includes any one or combination selected from In, Sb, Bi, and Tl.

31. (original) The apparatus as claimed in claim 1, wherein the excitation emitter is fabricated from semiconductor material that includes any one or combination selected from Hg, Cd, and Te.

32. (original) The apparatus as claimed in claim 31, wherein a concentration of cadmium (Cd) is between 20% and 30%.

33. (currently amended) The apparatus as claimed in claim 1, wherein the semiconductor diode includes a p-n junction, wherein a distance from a ~~p-n junction~~ in the p-n junction diode to the catalytic excitation collector is being less than three times a diffusion length of minority carriers in the ~~p-n junction~~ semiconductor diode.

34. (currently amended) The apparatus as claimed in claim 1, where the catalytic excitation collector further includes:

a catalyst,

wherein total path traveled by energetic carriers between a catalyst surface exposed to adsorbate reactants and a the semiconductor of the excitation emitter is less than three times the total energy mean free path associated with energy loss of the energetic carriers along the path.

35. (currently amended) The apparatus as claimed in claim 1, wherein ~~ballistic carrier transport is used to transport energetic carriers in the catalytic~~ the dimensions between the catalytic excitation collector and the excitation emitter are chosen to be small enough to permit predominantly ballistic carrier transport, which dimension is typically less than 3 times

the effective mean free path associated with energy loss of the ballistic carriers.

36. (currently amended) The apparatus as claimed in claim 1, wherein the apparatus further includes an ohmic electrical connection connecting the catalytic excitation collector and the excitation emitter.

37. (currently amended) The apparatus as claimed in claim 1, wherein the apparatus further includes a tunneling Schottky junction connecting the catalytic excitation collector and the excitation emitter.

38. (original) The apparatus as claimed in claim 34, wherein the catalyst includes one or more catalyst clusters.

39. (currently amended) The apparatus as claimed in claim 38, wherein the catalyst further includes one or more reaction accelerator-decelerator materials surrounding the one or more catalyst clusters.

40. (currently amended) The apparatus as claimed in claim 39, wherein the one or more reaction accelerator-decelerators include an oxide.

41. (original) The apparatus as claimed in claim 40, wherein the oxide includes one selected from titanium, cerium, rare earth metals, tin, lead, and aluminum.

42. (original) The apparatus as claimed in claim 40, wherein the oxide includes material of the catalyst.

43. (original) The apparatus as claimed in claim 38, wherein the catalyst further includes one or more reaction accelerator-decelerator adjacent to the one or more catalyst clusters.

44. (currently amended) The apparatus as claimed in claim 38, wherein the catalyst further includes one or more reaction accelerator-decelerators in contact with the one or more catalyst clusters.

45. (original) The apparatus as claimed in claim 34, wherein the catalyst has a Debye frequency less than the vibration decay frequency of the dominant mode of energy relaxation of at least one of adsorbate reactants.

46. (currently amended) The apparatus as claimed in claim 1, wherein the catalytic excitation collector includes a material having Debye temperature less than 500 degrees Kelvin.

47. (original) The apparatus as claimed in claim 34, wherein the catalyst includes material selected from any one of Au, Ag, Pt, Pd, Cu, In, Fe, Ni, An, and Mo.

48. (original) The apparatus as claimed in claim 34, wherein the catalyst is formed into metal clusters.

49. (original) The apparatus as claimed in claim 34, wherein the catalyst is formed into a quantum confinement structure.

50. (currently amended) The apparatus as claimed in claim 1, wherein the catalytic excitation collector further includes at least one electrode underlayer metal formed between the

excitation emitter and a catalyst in the catalytic excitation collector.

51. (currently amended) The apparatus as claimed in claim 50, wherein the electrode underlayer metal forms a substrate for one or more catalysts in the catalytic excitation collector.

52. (currently amended) The apparatus as claimed in claim 50, wherein the electrode underlayer metal forms a substrate for one or more reaction accelerator-decelerators in the catalytic excitation collector.

53. (previously presented) The apparatus as claimed in claim 50, wherein the electrode underlayer metal has a thickness less than three times energy mean free path of the excitations going through it.

54. (original) The apparatus as claimed in claim 50, wherein an ohmic junction is formed between the electrode underlayer metal and the excitation emitter.

55. (original) The apparatus as claimed in claim 50, wherein a tunneling Schottky junction is formed between the electrode underlayer metal and the excitation emitter.

56. (original) The apparatus as claimed in claim 50, wherein an almost ohmic junction is formed between the electrode underlayer metal and the excitation emitter.

57. (original) The apparatus as claimed in claim 1, wherein the apparatus further includes an optical cavity coupled to a region of adsorbate reactions.



58. (currently amended) The apparatus as claimed in claim 57, wherein the optical cavity is tuned to a selected energy level transition in at least one of the excitation and band structure of at least one of the excitation emitter, the catalytic excitation collector, and the adsorbate.

59. (original) The apparatus as claimed in claim 57, wherein the optical cavity includes dielectric micro cavities.

60. (original) The apparatus as claimed in claim 57, wherein the optical cavity stimulates emission of radiation.

61. (currently amended) The apparatus as claimed in claim 57, wherein the optical cavity stimulates energy transitions of at least one of the excitation and band structure of the excitation emitter.

62. (original) The apparatus as claimed in claim 1, wherein the one or more forms of energy include pulsed energy.

63. (original) The apparatus as claimed in claim 62, wherein the one or more forms of energy include pulsed electrical energy.

64. (original) The apparatus as claimed in claim 62, wherein the one or more forms of energy include pulsed optical energy.

65. (currently amended) A method of converting adsorbate reaction energy into power, comprising:

coupling ~~one or more~~ at least one of excitation and band structures of an adsorbate-catalyst into ~~one or more~~ at least one of excitation and band structures of an excitation emitter;

optimizing the coupling to a diode in the excitation emitter; and

converting one or more excitations in the diode to power.

66. (currently amended) The method of claim 65, wherein the coupling includes forming a catalytic excitation collector in the adsorbate-catalyst with one or more quantum confinement surface structures.

67. (currently amended) The method of claim 65, wherein the coupling includes tuning one or more optical cavities to a frequency of the ~~one or more~~ at least one of excitation and band structures of at least one of the adsorbate-catalyst and the excitation emitter.

68. (currently amended) The method of claim 65, wherein the coupling includes forming a catalytic excitation collector in the adsorbate-catalyst and the optimizing includes constraining the thickness of a region between a surface of the catalytic excitation collector exposed to adsorbate reactants and the excitation emitter, the region having a thickness of less than three energy mean free paths of hot carriers exchanged between the catalytic excitation collector and the excitation emitter.

69. (previously presented) The method of claim 65, wherein the optimizing includes selecting a substrate with band gap energy less than or equal to a selected excitation in the adsorbate-catalyst.

70. (previously presented) The method of claim 65, wherein the optimizing includes adjusting a forward bias of the diode such that a band of excitation energy in the excitation emitter matches a band of excitation energies in the adsorbate-catalyst.

71. (original) The method of claim 65, wherein the coupling includes selecting a catalyst with Debye frequency lower than a selected energy level of the one or more excitation structures of the adsorbate-catalyst system.

72. (currently amended) A method of converting reaction energy into power, comprising:

converting a fraction of the energy of one or more adsorbate reactants into hot carriers;

~~keeping the hot carriers hot while the hot carriers are transported~~

maintaining the hot carrier energy during hot carrier transport to a diode;

converting the hot carriers into a forward bias in the diode.

73. (original) The method of claim 72, wherein the method further includes:

converting the hot carriers into minority carriers;

conveying the minority carriers to a p-n junction region of the diode; and

generating a forward bias to generate power.

74. (original) The method of claim 73, wherein the power includes electricity.

75. (original) The method of claim 72, wherein the method further includes:

forming a population inversion by the hot carriers in the diode; and

extracting optical energy.

76. (currently amended) The method of claim 75, wherein the extracting includes extracting ~~laser action~~ by means of stimulated emission.

77. (original) The method of claim 75, wherein the extracting includes extracting super-radiant emissions.

78. (currently amended) The method of claim 72, wherein the method further includes:

modifying one or more electron density of states of a material in a catalytic excitation collector to match a selected range of energy transitions of ~~one or more~~ at least one of excitation and band structures of an adsorbate-catalyst system containing having the adsorbate reactants.

79. (original) The method of claim 78, wherein the modifying includes forming one or more catalyst monolayers.

80. (currently amended) The method of claim 78, wherein the modifying includes forming one or more ordered electron-reflective structures, also referred to as metal quantum wells and as Fabry-Pérot modes of quantum-well structures states, on a surface exposed to the adsorbate reactants.

81. (original) The method of claim 78, wherein the modifying includes forming one or more ordered hole-reflective structures on a surface exposed to the adsorbate reactants.

82. (original) The method of claim 78, wherein the modifying includes forming one or more hot electron Fabry-Perot modes of a thin-film electron interferometer.

83. (original) The method of claim 78, wherein the modifying includes forming one or more catalyst monolayers.

84. (original) The method of claim 78, wherein the modifying includes forming one to one hundred catalyst monolayers.

85. (original) The method of claim 78, wherein the modifying includes forming one or more integer catalyst monolayers.

86. (original) The method of claim 78, wherein the modifying includes forming one or more electron interferometer structures to cause a plurality of electron path reflections.

87. (original) The method of claim 72, wherein the method further includes adding one or more expendable additives to the adsorbate reactants.

88. (original) The method of claim 87, wherein the expendable additives include one or more catalyst materials.

89. (original) The method of claim 87, wherein the expendable additives include one or more reaction accelerator-decelerator materials.

90. (currently amended) The method of claim 72, wherein the one or more adsorbate reactants have a partial pressure such that no more than one monolayer for each of the one or more adsorbate reactants ~~is formed~~ accumulates during the surface reactions.

91. (original) The method of claim 90, wherein the partial pressure is less than ten atmospheres.

92. (original) The method of claim 72, wherein at least one of the adsorbate reactants is gaseous.

93. (original) The method of claim 72, wherein the one or more adsorbate reactants include one or more decelerator materials.

94. (original) The method of claim 72, wherein the one or more adsorbate reactants include one or more accelerator materials.

95. (original) The method of claim 72, wherein the one or more adsorbate reactants include one or more hydrocarbon chains.

96. (original) The method of claim 72, further including: cooling the diode with a heat of vaporization of the one or more adsorbate reactants.

97. (original) The method of claim 72, further including: cleaning a catalyst by a reaction of the one or more adsorbate reactants.

98. (currently amended) A reversible solid state surface catalysis excitation transfer reaction apparatus comprising:  
a catalytic excitation collector; and

an excitation emitter whose excitation band structure is coupled to at least one of excitation and band structure associated with the catalytic excitation collector and its associated chemical adsorbates,

wherein one or more energies ~~occurring in~~ associated with reactions of adsorbates associated with the catalytic excitation collector are converted into excitations and transported to the excitation emitter where emitter excitations are generated and

converted into one or more forms of energy, and

wherein an energy applied to the an excitation emitter creates the emitter excitations, the emitter excitations transported to adsorbates in the catalytic excitation collector where the transported emitter excitations energize the excitations, the excitations causing reaction stimulation in the catalytic excitation collector.

99. (original) The apparatus as claimed in claim 98, wherein the energy applied to the excitation emitter is pulsed electric power.

100. (original) The apparatus as claimed in claim 98, wherein the reaction stimulation generates hot carriers.

101. (original) The apparatus as claimed in claim 100, wherein the hot carriers further stimulate additional reactions.

102. (currently amended) A method of stimulating reactions, comprising:

providing a gas containing reactants to one or more catalyst surfaces of one or more excitation collectors in contact with one or more excitation emitters, wherein one or more of the reactants in the gas adsorb on a catalyst surface of an excitation collector;

creating hot carriers in an excitation emitter by applying energy to it, providing a means to transport the hot carriers of an excitation emitter to a surface of an excitation collector containing adsorbed reactants;

wherein the providing includes constraining the thickness properties of the one or more excitation collectors and one or more catalysts such that the hot carriers do not lose a substantial fraction of their energy while they are being

transported.

~~creating hot carriers in an excitation emitter, the  
excitation emitter in contact with a catalytic collector, by  
applying power to a diode in the excitation emitter,  
transporting the hot carriers originating in the diode into  
the catalytic collector having catalyst material,  
manipulating thickness properties of the catalyst material  
such that the hot carriers remain hot while they are transported  
to a surface of the catalytic collector, the surface being  
exposed to reactants.~~

103. (original) The method of claim 102, wherein an electrical power pulse is applied to forward bias the diode.

104. (original) The method of claim 102, wherein the power applied includes electrical power pulse with duration shorter than a lifetime of a longest lived excited state of the hot carriers.

105. (currently amended) The method of claim 102, wherein the power applied includes electrical power pulse with duration shorter than a lifetime of polariton states also referred to as localized excitations of a surface adsorbate.

106. (original) The method of claim 102, wherein the power applied includes electrical power pulse with duration less than 1 nanosecond.

107. (original) The method of claim 102, wherein the power applied includes electrical power pulse with duty cycle less than 1/2.

108. (original) The method of claim 102, wherein the power



applied includes electrical power pulse with repetition times comparable to or less than an average time during which gaseous reactants can replenish a surface of depleted reactants.

109. (original) The method of claim 102, wherein the power applied includes electrical power pulse with repetition rate higher than 50 megahertz.

110. (previously presented) The method of claim 102, wherein the reactants have a partial pressure such that not more than one monolayer forms for each of the reactants on a surface of the catalyst material.

111. (original) The method of claim 102, wherein at least one of the reactants is gaseous.

112. (currently amended) The method of claim 102, wherein the method further includes:

~~modifying one or more~~ tailoring electron density of states of the catalytic excitation collector to approximately match a selected range of energy transitions of one or more excitation band structures of an adsorbate-catalyst system ~~having~~ including the reactants.

113. (original) The method of claim 112, wherein the modifying includes forming one or more catalyst monolayers.

114. (original) The method of claim 112, wherein the modifying includes forming one or more ordered electron-reflective structures on the surface exposed to the reactants.

115. (original) The method of claim 112, wherein the modifying includes forming one or more ordered hole-reflective structures on the surface exposed to the reactants.

116. (original) The method of claim 112, wherein the modifying includes forming one or more hot electron Fabry-Perot modes of a thin-film electron interferometer.

117. (original) The method of claim 112, wherein the modifying includes forming one or more catalyst metal monolayers.

118. (original) The method of claim 112, wherein the modifying includes forming one to one hundred catalyst metal monolayers.

119. (original) The method of claim 112, wherein the modifying includes forming one or more integer catalyst metal monolayers.

120. (original) The method of claim 112, wherein the modifying includes forming one or more electron interferometer structures to cause a plurality of electron path reflections.

121. (original) The method of claim 102, wherein the method further includes adding one or more expendable additives to the reactants.

122. (original) The method of claim 121, wherein the expendable additives include one or more catalyst materials.

123. (original) The method of claim 121, wherein the expendable additives include one or more reaction accelerator materials.

124. (original) The method of claim 121, wherein the expendable additives include one or more reaction decelerator materials.

125. (original) The method of claim 102, wherein the reactants include hydrocarbon chains.

126. (currently amended) The method of claim 102, wherein the reactants deposit one or more compounds on the catalytic excitation collector.

127. (currently amended) The method of claim 102, wherein the reactants include one or more compounds that form at least part of the catalytic excitation collector.

128. (original) The method of claim 102, wherein reaction stimulated by the hot carriers cause a surface explosion.

129. (original) The method of claim 102, wherein reaction stimulated by the hot carriers cause an autocatalyzed chain reaction.

130. (original) The method of claim 102, further including cooling the diode with heat of vaporization of the reactants.

131 - 139. (original) (These claim numbers were not included in the original application)

140. (currently amended) A solid state surface catalysis excitation transfer reaction apparatus comprising:

a catalytic excitation collector ; and

an excitation emitter whose excitation band structure is

coupled to at least one of excitation and band structure associated with the catalytic excitation collector,

wherein an energy applied to the excitation emitter creates one or more ~~emitter~~ excitations, the ~~emitter~~ excitations transported to reactants ~~in~~ on the catalytic excitation collector, where the transported ~~emitter~~ excitations energize excitations in reactants on or near the catalytic excitation collector, the excitations stimulating reactions.

141. (original) The apparatus as claimed in claim 140, wherein the ~~emitter~~ excitations include minority carriers.

142. (original) The apparatus as claimed in claim 140, wherein the emitter excitations include hot carriers.

143. (currently amended) A solid state surface catalysis excitation transfer reaction apparatus comprising:

~~a catalytic collector~~ one or more catalytic excitation collectors; and

~~an excitation emitter~~ one or more excitation emitters whose at least one of excitation and band structures is coupled to at least one of excitation and band structures associated with one or more of the catalytic excitation collectors,

wherein one or more pulses of excitation associated with reactions of adsorbates ~~occurring in the~~ associated with a catalytic excitation collector are converted into one or more second excitations and transported to ~~the excitationa emitter~~ where ~~emitter excitations are generated and converted into one or more forms of energy.~~ a collector where reactions are stimulated.

144. (currently amended) The apparatus of claim 143, wherein the reactants include one or more of gaseous reactants and adsorbates of the gaseous reactants

145. (original) The apparatus of claim 143, wherein the pulses of excitation include excited reactant molecular vibrations.

146. (currently amended) The apparatus of claim 143, wherein the reactions of adsorbates occur on a surface of ~~the~~ a catalytic excitation collector.

147. (currently amended) The apparatus of claim 143, wherein the reactions of adsorbates occur with a surface of the catalytic excitation collector.

148. (original) The apparatus of claim 143, wherein the emitter excitations include hot carriers.

149. (original) The apparatus of claim 143, wherein the emitter excitations include minority carriers.

150. (original) The apparatus of claim 149, wherein the one or more second excitations include hot carriers.

151. (currently amended) The apparatus as claimed in claim 1, wherein the ~~emitter~~ excitations include energies transported by resonant tunneling.

152. (currently amended) The apparatus as claimed in claim 1, wherein the catalytic excitation collector further includes a catalyst, a material of the catalyst and an electrode of the p-n junction diode being one and the same.

153. (currently amended) The method of claim 70, wherein a hot carrier is an electron and the excitation band of the diode

~~emitter~~ is its conduction band.

154. (currently amended) The method of claim 70, wherein a hot carrier is a hole and the excitation band of the diode ~~emitter~~ is its valence band.

155. (currently amended) The method of claim 72, wherein the method further includes:

modifying one or more electron density of states of a material in a catalytic collector to match at least one of a selected excitation and band structure of an adsorbate-catalyst system having the adsorbate reactants.

156. (currently amended) The method of claim 78, wherein the ~~modifying~~ tailoring includes forming one or more electron interferometer structures to cause a plurality of hole reflections.

157. (currently amended) A method of stimulating reactions, comprising:

applying power to a diode in an excitation emitter, the excitation emitter being in contact with a catalytic excitation collector;

creating hot carriers in the excitation emitter;

coupling excitation energy of the hot carriers to at least one of an excitation and band structure of the catalytic excitation collector by using resonant tunneling;

constraining the thickness properties of a coupling material of the catalytic excitation collector such that the resonant tunneling of the excitation energy experiences an energy transfer rate between excitation emitter and catalytic excitation collector not less than 3% of the competing, energy loss rates.

158. (currently amended) The method of claim 157, wherein the constraining the thickness properties includes constraining the thickness to less than 200 nanometre (nm) for a conducting coupling material of the catalytic excitation collector.

159. (currently amended) The method of claim 157, wherein the constraining the thickness properties includes constraining the thickness to less than 100,000 nanometre (nm) for a non-conducting coupling material of the catalytic excitation collector.

160. (new) A method of claim 102, wherein the creating hot carriers includes energizing a two terminal device of an excitation emitter by applying electrical energy.

161. (new) A method of claim 160, wherein the two terminal device includes one or more of a diode, semiconductor diode, metal-insulator-metal device, or a conductor-semiconductor-conductor device.

162. (new) A method of claim 102, wherein the applying energy to an excitation emitter includes applying pulses of energy.

163. (new) A method of claim 162, further including constraining the duration of the pulses to less than 50 picoseconds.

164. (new) A method of claim 102, wherein the applying energy to an excitation emitter includes applying pulses of energy with high peak power and low average power.

165. (new) A method of claim 164, further including using a

ratio of peak to average power that exceeds 10.